

ORBITAL ANOMALIES IN GODDARD SPACECRAFT
FOR
CY 1991

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Summary

This report presents a summary of the in-orbit reliability performance of spacecraft built under the management of the Goddard Space Flight Center that were active during calendar year 1991. It is one of a series of such reports that collectively form a continuous published record of this performance. The major feature of these reports is a log of all anomalies occurring during the report period which provides a description of the anomaly and its time of occurrence. Each anomaly is classified according to criticality, type, subsystem, and other relevant criteria. Although some statistical analysis comparisons are given, the purpose of the report is primarily documentary, with more extensive statistical treatment to be presented elsewhere.

Introduction

Since the earliest days of the Center, attempts have been made to record the performance of Goddard-managed spacecraft. Although statistical summaries exist, it is only in about the last 25 years that more detailed data was gathered and published in various forms. This data was found to be very useful and in 1983 a report containing very specific anomaly data was published. This was the contractor report Analysis of Spacecraft On-Orbit Anomalies and Lifetimes, PRC R-3579, dated February 10, 1983, which covers roughly the period from 1978 to mid-1982, and includes JPL as well as GSFC spacecraft. This was followed by Orbital Anomalies in Goddard Spacecraft 1982-1983 and yearly reports since, all published by the Office of Flight Assurance. The current report updates the record through 1991

Spacecraft Activity Schedule

At the beginning of this reporting period, on January 1, 1991, there were a total of 18 GSFC spacecraft in full or partial service. This number includes five meteorological spacecraft operated by NOAA consisting of three of the TIROS/NOAA series and two of the GOES series. Landsat-4 and Landsat-5 are operated by EOSAT.

Although the HST was not built under contract to GSFC (it was a MSFC program), it is listed in the report because flight operations and future refurbishment are assigned to GSFC.

There were four new spacecraft launched during the year and one older spacecraft mission was terminated. The GRO spacecraft was successfully launched in April followed in May by NOAA-D, which became NOAA-12 in orbit. In August another TDRS spacecraft was launched becoming TDRS-5, the fourth such data relay satellite in orbit. Finally the UARS was launched in September. The DE-1 spacecraft was terminated in March because it could not be commanded anymore. The complete list of satellites active during all or part of 1991 is as follows:

<u>NASA</u>		<u>NOAA</u>	<u>EOSAT</u>
COBE		NOAA-9	Landsat-4
DE-1 [terminated March 3]	O	NOAA-10	Landsat-5
ERBS	N	NOAA-11	
HST			
IMP-8	G		
ICE (ISEE-3)	O		
IUE	I		
NIMBUS-7	N	GOES-6	
TDRS-1	G	GOES-7	
TDRS-3			
TDRS-4			
GRO	NEW		
TDRS-5		NOAA-12	
UARS			

Details are shown in the Spacecraft Lifetime Data in Appendix A, which includes virtually all GSFC launches since 1960, excluding Shuttle attached payloads and a number of international missions Goddard participated in but is not considered to have had responsibility.

Overall there were 66 anomalies, distributed over 12 different spacecraft, during the year. No anomalies were reported in the following spacecraft: DE-1, ERBS, GOES-6, ICE, IUE, LANDSAT-4, LANDSAT-5, NOAA-9 or TDRS-3. The distribution of these anomalies among the spacecraft is presented in Figure 1. (This compares with 71 anomalies distributed over 13 spacecraft in the previous year, 1990).

In addition, the distribution of these 66 anomalies among the spacecraft subsystems is shown graphically in Figure 2. This figure shows that most of the anomalies occurred in the Instruments, the Telemetry and Data Handling Subsystem, and the Attitude Control Subsystem.

In the following sections, each mission and its overall performance is discussed in more detail. A complete log of anomalies appears at the end of the report in Table II.

Data Sources

The data reported herein are taken primarily from three sources. For NASA spacecraft, the main source is the Spacecraft Orbital Anomaly Reports (SOAR). For TIROS/NOAA spacecraft the TIROS Orbital Anomaly Reports (TOAR) are used, and the GOES Anomaly Reports (GAR) cover the GOES series. These data bases are maintained by the Assurance Requirements Office, in the case of SOAR, and the METSAT Office in the case of TOAR and GAR. The information contained in these reports originates in the corresponding spacecraft operations control centers.

Supplementary information is obtained through miscellaneous written reports, attendance of the regular meetings of the Orbiting Satellites Project, and other verbal contacts. Additional backup information on many of these anomalies is available through this office, and are subject to revision. This applies particularly to "open" anomalies.

Spacecraft Performance Summary

The following provides a summary of the condition and performance of the active spacecraft covered by this report. The classification of each spacecraft, according to GMI 8010.2, is listed after the spacecraft name.

COBE (Cosmic Background Explorer) CLASS B

This spacecraft continued to perform very well throughout the year. Science data from the Diffuse Infra-Red Background Experiment (DIRBE) and the Differential Microwave Radiometer (DMR) were gathered successfully. Early in the year the AX-Gyro's output became somewhat erratic so a switch to the BX-Gyro was made. In September the BX-Gyro failed and was replaced by the CX-Gyro. Other minor anomalies occurred that are contained in Table II.

DE-1 (Dvynamic Explorer) UNCLASSIFIED

It was decided in late 1990 to terminate operations at the end of February 1991. During January and February of this year the ability to command the spacecraft was lost and regained several times and eventually it was found on 2/5 that the tape recorder could not be dumped. An attempt to retract the antenna wires of the PWI Instrument was unsuccessful. Operations were terminated on March 3.

ERBS (Earth Radiation Budget Satellite) UNCLASSIFIED

The two remaining instruments on ERBS continued to operate very well during the year. There were no major failures or anomalies during the year. In September the spacecraft attained seven years in orbit.

GOES (Geostationary Operational Environmental Satellite) CLASS A

GOES-6: This spacecraft served as the WEST Spacecraft for the entire year at 135° West Longitude. It provided METEOSAT Image data, simulated GVAR data, West WEFAX, DCS and SEM support. Four East-West stationkeeping maneuvers were executed during the year.

Solar storm activity in March caused an uncommanded switch of the Central Telemetry Unit from normal to dwell mode of operation and caused a degradation of about 0.2 amps. in solar array output. Only about 4.3 lbs. of fuel remain on board.

GOES-7: Designated the PRIME spacecraft, it was stationed at two places during the year; 108°W during Winter/Spring for better coverage of Pacific storms and 98°W during Summer/Fall to provide better coverage of Atlantic hurricanes. The solar storm activity caused a loss of 0.2 amps. in the solar array output and also some SEUs which were easily corrected. There was an anomaly in the GOES ranging system in August. RF power output from the primary and redundant sides of the ranging system had degraded considerably although it is still sufficient for ranging. GOES-7 provided VAS imaging/sounding, simultaneous WEFAX, East DCPR, SEM and SAR all year. In December a drift towards 112° was initiated. It is estimated that 32 lbs. of fuel remained aboard at the end of the year.

GRO (Gamma Ray Observatory)

CLASS B

This new observatory was deployed from the shuttle (STS-37) on April 7. After checkout the spacecraft started its planned science program about a month later. Over the summer some problems were experienced with the transponders locking up and preventing the commanding of the spacecraft. This was due to RFI from the ground and a design fault in the transponders. Eventually a method for "unlocking" the transponders when this occurred was developed. In early September a bit error problem on Tape Recorder A was noticed on playback of data. This condition got progressively worse and in December the errors became so high that a switch to Tape Recorder B was made. The science data being obtained from this spacecraft has been excellent.

HST (Hubble Space Telescope)

CLASS B

(NOTE: Build under MSFC contract.)

In June the second gyro on HST, No. 4, failed intermittently and finally would no longer respond to commands. In late July Gyro No.5's motor current increased to a level over the normal limit although it is still operating. In late September the solar array output decreased by seven amps.; possible cause is a stuck relay. There were a number of other minor anomalies during the year which are documented in Table II. Despite the many problems with the spacecraft, much valuable science was conducted throughout the second year of operation.

ICE (International Cometary Explorer)

UNCLASSIFIED

[Originally ISEE-3]

In August this "old-timer" had its 13th anniversary of service in orbit. It is still providing useful data although its priority is low when competing with other spacecraft utilizing the Deep Space Network. There were no reported anomalies in 1991.

IUE (International Ultraviolet Explorer)

UNCLASSIFIED

This spacecraft also reached its 13th year in orbit at the beginning of this year and continues to produce good astronomical data. Gyro No. 5, which has continued to have drift rate problems, was found to have only one operating winding on its motor,

but performance is nominal on that winding. In March a successful "one gyro" test was run and a procedure is now available for spacecraft control when only one gyro is left. In September there was evidence that a Flux Particle Monitor had failed.

Landsat-4

UNCLASSIFIED

There were no anomalies reported in 1991 and the MSS (Multi-Spectral Scanner) and TM (Thematic Mapper) continue to produce images despite the degraded power system. The spacecraft has been operating for nine years.

Landsat-5

UNCLASSIFIED

Like Landsat-4 this spacecraft continues to provide MSS and TM images after seven years in orbit. No anomalies were reported this year.

Nimbus-7

UNCLASSIFIED

This spacecraft experienced some minor anomalies during the year but reached 13 years in orbit with three instruments still providing worthwhile data: Stratospheric Aerosol Measurement (SAM II), Solar Backscatter Ultraviolet/Total Ozone Mapping Spectrometer (SBUV/TOMS) and Earth Radiation Budget (ERB).

NOAA-9

CLASS B

Although this spacecraft remained in standby status all year it was utilized for data retrieval from the ERBE-NS and SBUV Instruments. NASA began acquiring and processing data from these instruments in mid-April. On May 21 spacecraft control was lost during a test of new gyroless software. Control was regained but the ERBE-NS and SBUV were not fully restored to their operational modes for some time: the SBUV was restored on June 11 and ERBE-NS was not started up again until September when NOAA took over the processing of data. NOAA is also processing and distributing SARP data. In August the spacecraft was successfully flown with modified no-gyro software. This will be further tested before similar software, loaded on NOAA-11 in April, is placed in the active mode to take over control if the X gyro should fail. No anomalies were reported since this spacecraft is officially on standby status.

NOAA-10

CLASS B

This satellite was the operational "morning" polar orbit satellite until early September when NOAA-12 became operational in that capacity. In January, in order to reduce noise levels on AVHRR Ch. 3, the IR channels were turned off and the cooler heater was turned on to outgas the instrument for a week. The outgassing was successful and the noise was decreased appreciably. In the first quarter of the year an anomaly appeared in the MEPED in the SEM Instrument: high counts in 0 degree electron channel. An attempt was made to correct the problem by turning off parts of the instrument for a week or so. There was no recovery as a result of this exercise. In

May the SEM was turned off completely because of anomalous behavior in DIGA telemetry and the TED Channeltron. In September the NOAA-10 was placed in standby operation with NASA recovering and processing ERBE-NS data for LaRC.

NOAA-11

CLASS B

This satellite continued to be the operational "afternoon" polar orbit satellite during the year. This spacecraft has a failed Y-gyro and an intermittent Z-gyro (pitch). In April new "no gyro" software was successfully loaded in this satellite and is in a passive monitor mode. However it will take over control if the X-gyro should fail. In May the AVHRR motor current and sync delta word increased significantly and seem to be trending upward. This has been seen in similar instruments as they age and the bearing lubricant decreases. This has not affected the imagery to date. The operation did briefly become erratic but warming the instrument improved the situation and by late June the AVHRR was very stable. In September some phantom commands occurred that seem to be caused by a noisy VHF environment. No problems resulted from these "commands". In October and November the Digital Tape Recorder 1B suffered from intermittent anomalous behavior related to non-acceptance of commands or missing playbacks. The cause was not determined and by year's end it seemed to be behaving normally again.

NOAA-12

CLASS B

This spacecraft (was NOAA-D) was launched on May 14th into a nominal orbit without incident. After a couple of weeks the satellite performance was nominal. All instruments were fully operational by June 10 when the satellite was turned over to NOAA for early operations. It became the "morning" orbit operational satellite in early September, replacing NOAA-10. In September and following months the spacecraft was hit with a number of phantom commands, mostly over Europe. It is probably due to the susceptibility of the VHF receiver and the increasingly active VHF commercial environment in Europe. None of these "commands" caused any problems and were routinely countermanded. Through much of October the AVHRR motor current increased and became erratic. However it finally settled down to normal levels and was operating fine at year's end. In late November the SEM TED high voltage turned off autonomously; it was commanded back to its normal configuration and has behaved normal. Anomaly reports, written on some of these and other minor anomalies are contained in Table II.

TDRS (Tracking and Data Relay Satellite)

CLASS A

TDRS-1: This spacecraft continued in a standby mode for all of 1991. There was only one anomaly written on this spacecraft dealing with a SSA-1R channel failure.

TDRS-3: This spacecraft continued to serve as TDRS-WEST until August when the newly launched TDRS-5 became TDRS-WEST. At that time the TDRS-3 was placed into standby status. No anomalies were reported on this craft in 1991. This

spacecraft has experienced relatively few anomalies since launch in 1988 and is in fairly good health.

TDRS-4: This spacecraft continued to serve as TDRS-EAST throughout this year. There were some minor anomalies reported during the year but all were fairly minor. They are reported in Table II.

TDRS-5: TDRS-E was successfully launched on August 2 by STS-43 and shortly thereafter became operational as TDRS-WEST. This spacecraft has experienced some minor anomalies (Table II) but nothing serious.

UARS (Upper Atmosphere Research Satellite): CLASS B

This spacecraft was successfully placed in orbit on September 15 by STS-48. The spacecraft is behaving very well and all the instruments are operating and providing good data. There were some operational anomalies in the remainder of the year but science taking was not hindered.

Anomaly Data: Classification and Description

In the table of anomalies (Table II), the following information is provided:

1. Index -- This is a chronological enumeration of the anomalies, beginning at launch. Numbers lower than the first number used in this report will be found in earlier reports of the series.
2. Date -- This is the date of the occurrence of the anomaly, and in parentheses the number of days since launch is given, counting launch day as one.
3. Subsystem -- For the purposes of this data base, the spacecraft is divided into nine subsystems. These are:
 1. Attitude Control and Stabilization (ACS)
 2. Power
 3. Propulsion
 4. Structure
 5. Telemetry & Data Handling (TLM&DH)
 6. Thermal
 7. Timing, Control & Command (TC&C)
 8. Instrument (payload)
 9. Other (name to be entered)
4. Criticality -- This describes the impact of the anomaly on the mission, according to the following schedule:

1. Negligible	(0 - 5% loss)
2. Non-negligible but small (Minor)	(5 - 33%)
3. 1/3 - 2/3 Mission Loss (Substantial)	(33 - 66%)
4. 2/3 to Nearly Total Loss (Major)	(66 - 95%)
5. Essentially Total Loss (Catastrophic)	(95 - 100%)
5. Description -- A brief description of the anomaly and its probable cause, if known.
6. Effect/Action -- The effect of the anomaly on the mission and corrective action, either for this mission or future missions, if any and if known.
7. Reference -- The number on the SOAR, TOAR, or GAR (if any) covering this particular incident.

Anomalies are also classified in various ways for the purpose of statistical analysis. SOAR calls for the following classifications:

ITEM	CODE	DESCRIPTION
Anomaly Effect:	1	Spacecraft failure
	2	Subsystem/instrument failure
	3	Component failure
	4	Assembly failure
	5	Part failure
	6	Subsystem/instrument degradation
	7	Indeterminate
	8	Loss of redundancy
	9	None
Failure Category:	1	Design problem
	2	Workmanship problem
	3	Part problem
	4	Environmental problem
	5	Other (w/explanation)
	6	Unknown
Type of Anomaly:	1	Systematic (would occur if identical equipment were operated under identical circumstances)
	2	Random
	3	Wearout (a special case of systematic)
	4	Indeterminate
	5	Intermittent
	6	Normal/Expected Operation

These classifications for the 1991 anomalies are given in Table I.

Using the data in Table I, the 66 "1991 anomalies" can be summarized in various ways. These are presented, following Table I, in various tables and graphs.

TABLE I
CLASSIFICATION OF 1991 ANOMALIES

Spacecraft	A	B	C	D	E	F
COBE	14	1	2	9	5	3
	15	5	1	4	3	4
	16	1	2	3	6	4
	17	1	2	3	5	3
	18	1	2	6	6	1(5)
	19	7	1	6	6	1
GOES-7	18	5	1	6	6	4
GRO	1	5	2	9	2	1
	2	3	3	4	1	1
	3	3	1	9	6	4
	4	8	2	5	3	2
	5	5	2	6	1	1(5)
	6	5	1	6	6	1
	7	8	1	6	6	4
	8	8	1	6	6	4
	9	5	2	6	1	1(5)
	10	5	1	6	1	1(5)
	11	5	2	6	6	1
	12	8	1	6	6	4
	13	2	1	6	6	4
HST	[30	1	1	9	5	1] <1990
	[31	1	2	7	5	1] <1990
	32	8	1	6	6	1
	33	7	2	9	6	4
	34	1	2	5	3	4
	35	5	1	6	6	4(5)
	36	2	1	7	6	4
	37	5	1	5	3	4
	38	1	2	3	6	1
	39	8	2	9	5	1
	40	8	2	6	6	4(5)
	41	1	1	9	1	1
	42	8	1	9	6	4(5)
	43	2	2	6	6	4
	44	6	1	9	1	1(5)
	45	1	1	9	6	4(5)
	46	7	1	9	6	4(5)
	47	5	1	9	1	1
	48	5	1	9	5	1(5)

Spacecraft	A	B	C	D	E	F	
Nimbus-7	64	5	1	9	6	4(5)	
	65	5	1	9	6	4(5)	
	66	5	2	9	6	4(5)	
	67	8	2	9	6	4(5)	
NOAA-10	22	8	1	5	3	1	
	23	8	1	6	6	4	
NOAA-11	21	5	1	9	6	4(5)	
	22	8	1	6	1	1	
	23	7	1	9	5	1(5)	
	24	5	1	9	6	4(5)	
NOAA-12	1	1	1	9	6	4(5)	
	2	5	1	9	5	4(5)	
	3	8	1	6	6	4	
	4	2	1	9	4	1	
	5	7	1	9	6	4(5)	
	6	8	1	9	6	4	
	7	8	1	9	4	1	
TDRS-1	61	8	2	9	6	4(5)	
	62	.8	2	6	6	4	
TDRS-4	[15	2	2	9	5	1]	< 1990 Anomaly
	16	1	2	4	3	1	
	17	7	1	9	5	1	
	18	1	1	9	6	4(5)	
	19	1	1	9	6	4(5)	
	20	8	2	6	6	4	
TDRS-5	1	3	1	9	5	1	
	2	1	1	9	1	1	
	3	1	1	9	4	1(5)	
	4	8	1	9	1	4(5)	
UARS	1	8	1	9	1	4(5)	

A = Index

B = Subsystem

C = Criticality (Mission Effect)

D = Anomaly Effect

E = Failure Category

F = Type of Anomaly

<u>Criticality</u>	<u>No. of Anomalies ('91)</u>	<u>[1990]</u>
Negligible	44	[1]
Minor	21	[2]
Substantial (1/3 to 2/3 Mission Loss)	1	
Major (2/3 to Nearly Total Loss)	0	
Catastrophic (Total Loss)	0	

[SEE FIGURE 3]

The item listed above as "Substantial" is: GRO Propulsion Subsystem experienced damage when a pressure surge was generated when the isolation valve was opened right after launch.

<u>Anomaly Effect</u>	<u>No. of Anomalies ('91)</u>	<u>[1990]</u>
1. S/C Failure	0	
2. Subsys./Ins't Failure	0	
3. Component Failure	3	
4. Assembly Failure	3	
5. Part Failure	4	
6. Subsys./Ins't Degradation	21	
7. Indeterminate	1	[1]
8. Loss of Redundancy	0	
9. None	34	[2]

[SEE FIGURE 4]

<u>Failure Category</u>	<u>No. of Anomalies ('91)</u>	<u>[1990]</u>
1. Design Problem	10	
2. Workmanship Problem	1	
3. Part Problem	6	
4. Environmental Problem	3	
5. Other (w/explan.)	8	[3]
6. Unknown	38	

[SEE FIGURE 5]

<u>Type of Anomaly</u>	<u>No. of Anomalies ('91)</u>	<u>[1990]</u>
1. Systematic	27	[3]
2. Random	1	
3. Wearout	2	
4. Indeterminate	36	
5. Intermittent	26	
6. Normal/Expected Operation	0	

[SEE FIGURE 6]

1991 Anomalies Distribution Among Spacecraft

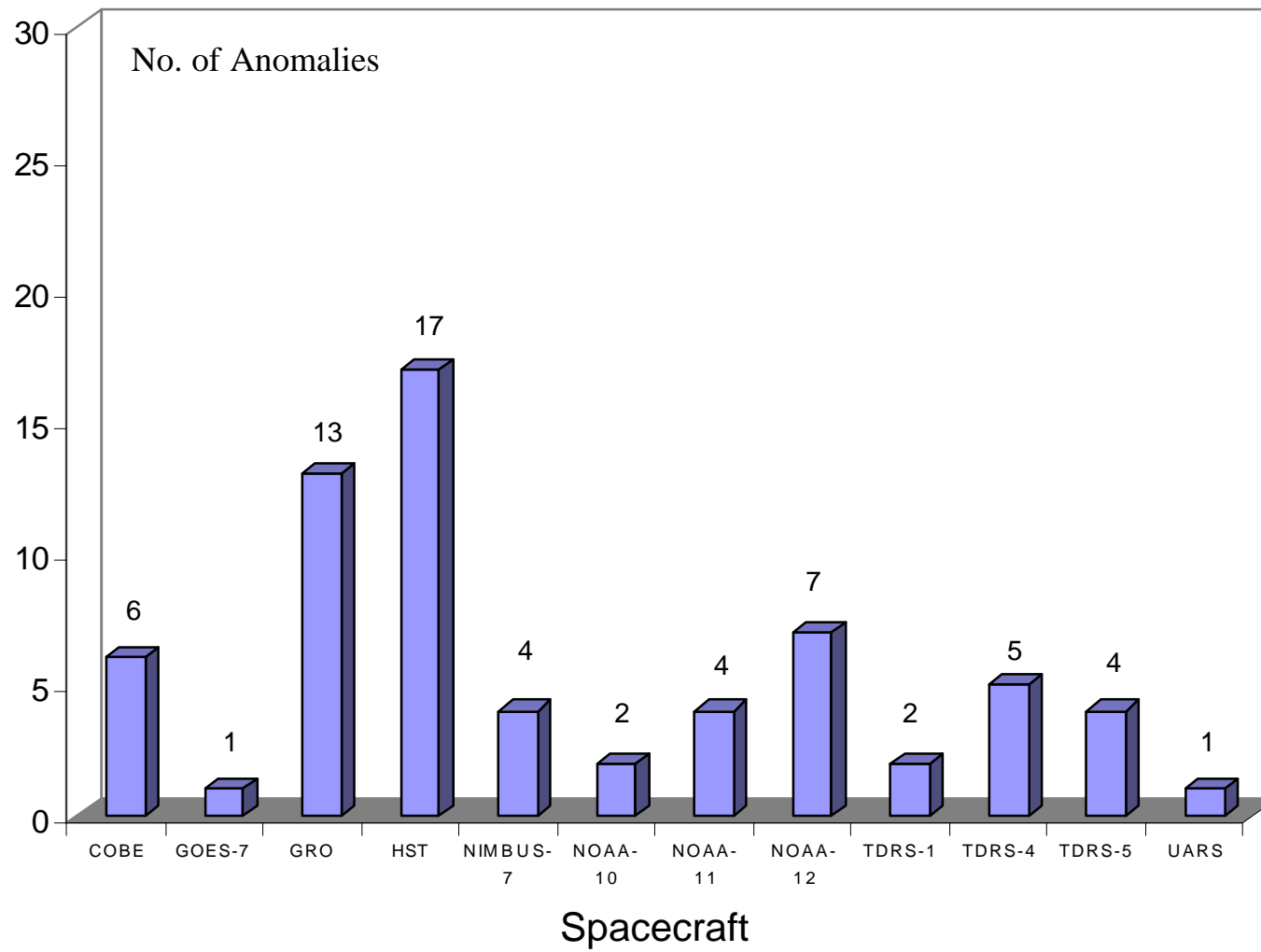
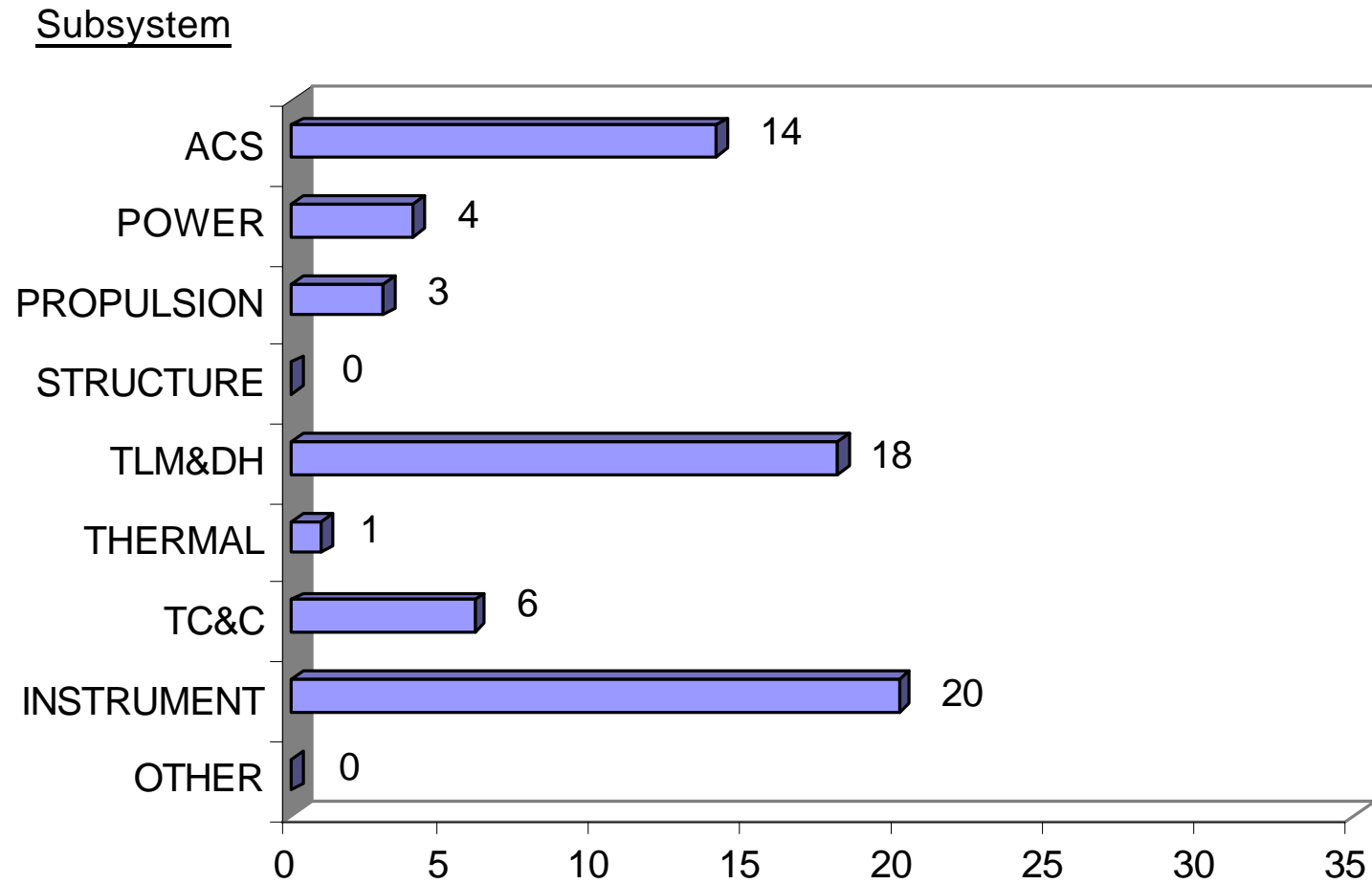


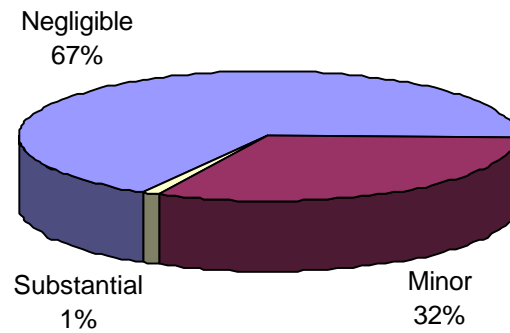
Figure 1

1991 Anomalies
Distribution Among Subsystems

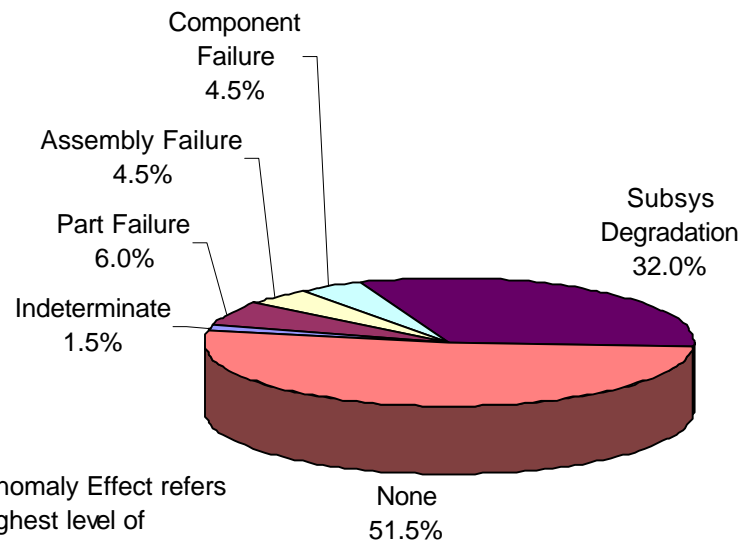


No. of Anomalies - Figure 2

Orbital Anomalies in Goddard Spacecraft (CY 1991)



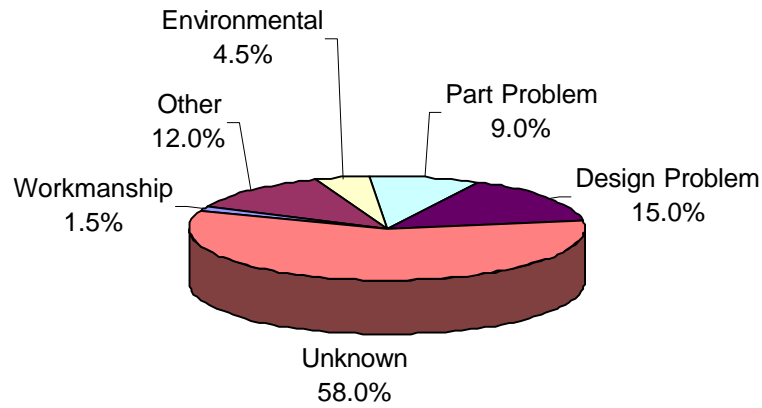
Mission Effect (Criticality) – Figure 3



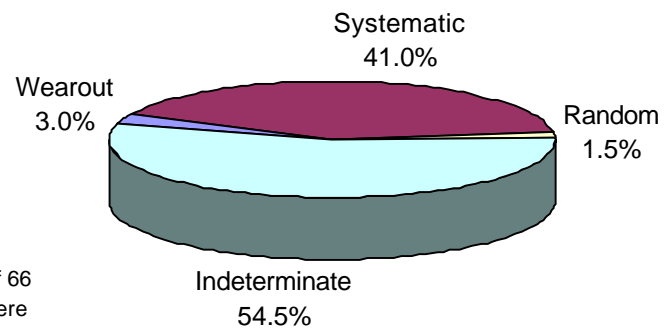
Note: Anomaly Effect refers to the highest level of assembly the anomaly has affected

Anomaly Effect - Figure 4

Orbital Anomalies in Goddard Spacecraft (CY 1991)



Failure Category - Figure 5



Note: 39% of 66
Anomalies were
classified as
Intermittent

Type of Anomalies - Figure 6

TABLE II

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
<u>COBE</u>						
14	1/2/91 (410)	ACS	2	Instability in AX gyro drift rate - gyro wearout.	No effect on attitude control/switch to BX gyro on 3/20/91.	A-01284
15	7/26/91 (615)	TLM&DH	1	Signal Cond. Unit power supply failed – caused loss of some temperature readings.	Negligible/ switched to back-up power supply later.	A-01504
16	8/26/91 (646)	ACS	2	Control Electronics (CE-1) failed - processes gyro-C signals.	Affected gyro-C signals/auto switchover to CE-2.	A-01505
17	9/7/91 (658)	ACS	2	Sudden complete failure of BX gyro (bearing failure)	No impact on attitude control/ switched to backup CX gyro.	A-01506
18	10/16/91 (697)	ACS	2	Earth scanners periodically show diagnostic and other "flags" (1 per week).	Small S/C attitude glitches/ none	A-01507
19	12/30/91 (772)	TC&C	1	PB-5 clock (frequency standard) drift rate continues to increase.	minor/regular adjustments required.	A-01104

DE-1

NO ANOMALIES REPORTED IN 1991.
(DE-1 MISSION TERMINATED IN
MARCH)

ERBS

NO ANOMALIES REPORTED IN 1991.

GOES-6

NO ANOMALIES REPORTED IN 1991.

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
<u>GOES-7</u>						
18	8/7/91 (1623)	TLM&DH	1	Ranging unit 1 output power was degraded (10 mw vs. 96 mw) but usable (unit 2 unusable).	minimal/none	129
<u>GRO</u>						
1	4/7/91 (0)	TIAM&DH	2	High Gain Antenna stuck at beginning of deployment. EVA required to free it.	Successful deployment/ Astronaut EVA	
2	4/7/91 (0)	Propulsion	3	Large pressure surge damaged transducer when isolation valve was opened.	May restrict use of Propulsion Subsystem/none.	
3	4/7/91 (0)	Propulsion	1	Higher than normal temperature on one heater circuit on OAT-2. Has not repeated.	Negligible/none	
4	4/19/91 (12)	INST+ BATSE	2	Computer chip, that enables view of some Pulsars, malfunctioned.	Minor/switched to redundant side.	
5	6/23/91 (77)	TLM&DH	2	Temperary loss of communications (13 hours) caused by transponder being locked out by strong signal (spike) from ground.	Some science lost/Repeated tries unlocked transponder.	
6	7/(10)/91* (94)	TLM&DH	1	Some Cyclical Redundancy Check errors seen in Tape Recorder A data.	Negligible/none required.	
7	7/(20)/91* (104)	INST+ COMPTEL	1	Two detectors (DI-04 and D2-14) display high voltage related noise.	minor/none	
8	8/(10)/91* (125)	INST+ COMPTEL	1	A gradual increase in high threshold count rate seen in CAL A Detector,	Negligible/none	
9	8/17/91 (132)	TLM&DH	2	Transponder/Receiver-B experienced lock-out condition (Receiver-A OK)	13.5 hours lockout/actions finally unlocked.	

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
10	10/(15)/91* (191)	TIM&DH	1	Lock-out occurred again on Transponder-A.	No science data lost/ unlocked	
11	11/27/91 (234)	TLM&DH	2	Bit errors increased quickly on Tape Recorder-A.	Data affected/switched to Tape Recorder-B.	
12	11/(30)/91*	INST+ EGRET	1	Automatic detection & flag mode for microsecond bursts is not functioning properly.	Minimal/none, reason unknown.	
13	12/5/91 (242)	POWER	1	Differential voltage starting to increase in Battery-1 in MPS-1	Affects power management/ watch closely.	
<u>HST</u>						
**30	[12/11/90) (231)	ACS	1	Two guide star acquisitions failed because FHST-2 could not locate stars.	Timed out/ Adjusted tolerance for all trackers.	031
**31		ACS	2	HST entered Inertial Hold Safemode after failing Earth/Moon bright object test.	Servo spun continuously/ Contingency op procedure to Stop spin.	032
32	4/27/91 (368)	INST+ GHRS	1	GHRS Carousel failed to achieve lock on commanded position.	Could not perform science/ modify software to correct.	033
33	5/2/91 (373)	TC&C	2	S/C entered hardware sunpoint safemode initiated by DF-224 computer. Cause unknown - did not re-occur.	Put in safemode/ none.	034
34	6/19/91 (421)	ACS	2	Gyro-4 experienced intermittent failures (saturation) and on 7/1/91 it would not respond to commands.	Not usable/none	035
35	7/1/91 (433)	TLM&DH	1	Six status monitors failed in South Atlantic Anomaly (SAA). Possible radiation damage.	Loss of monitors/ none	036

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
36	7/10/91 (442)	POWER	1	Status monitor on solar array changed from a log "1" to "0" and +DD SPA had disconnected.	Loss of status/ none	037
37	7/10/91 (442)	TLM&DH	1	Eight SA monitors exhibited anomalies during day but all right during dark.	Loss of monitors/ none	038
38	7/26/91 (458)	ACS	2	Gyro-5 motor current increased beyond its upper limit - probable transient short of wheel supply voltage.	Loss of gyro/ none	039
39	7/28/91 (460)	INST+FOS	2	Instrument safed as result of failed binary mode 11 target acquisition.	Instrument ops delayed/ software command was placed on-board.	040
40	8/5/91 (468)	INST+GHRS	2	SDF behaved anomalously. Intermittent failure of Side 1 power supply.	Science data disabled & instrument safed/ leave power supply always "on."	041
41	8/16/91 (479)	ACS	1	Body rate error low mode count flagged high. PORTS limit violation.	Negligible/ increased body count limit.	042
42	8/18/91 (481)	INST+GHRS	1	SDF behaved anomalously during engineering test. Both NSSC-1 and GHRS detected errors in SDF interface.	Neglibible/none at present SDF was restored.	043
43	9/23/91 (517)	POWER	2	Solar array current dropped by 7 amps - relay may be stuck in open position.	Reduces current available for charging batteries/ FRB convened.	044
44	9/26/91 (520)	THERMAL	1	Tray heater temperature alarm occurred at 31°C. (Limit set at 30.3°C.	Negligible/none	045
45	11/6/91 (561)	ACS	1	Gyro-1 had higher than normal noise level – other gyros did not have noise.	Negligible/none	046

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
46	11/21/91 (576)	TC&C	1	CD1-A block counter incremented when no commands were being sent - PORTS suspected.	Negligible/none	047
47	12/9/91 (594)	TLM&DH	1	S/C entered inertial hold safemode due to detection by DF 224 of over 5 minutes of HGA-1 torques exceeding 10 in-ozs.	Put in safe mode/ PASS code needs changing.	048
48	12/30/91 (615)	TLM&DH	1	Many mission scheduling errors have occurred with HST Command Load.	often cause loss of S/C data/ fix software.	049

ICE

NO ANOMALIES REPORTED IN 1991.

IUE

NO ANOMALIES REPORTED IN 1991.

LANDSAT-4

NO ANOMALIES REPORTED IN 1991.

LANDSAT-5

NO ANOMALIES REPORTED IN 1991.

NIMBUS-7

64 A-01251	1/7/91 (4458)	TLM&DH	1	Auto relay failed to close preventing transponder-A coming on at station acquisition.	None/manually turned on transponder.	A-01251
65 A-01252	8/25/91 (4688)	TLM&DH	1	Relay failed to unlock and turn off transponder-A at end of station pass. At next station pass it operated satisfactorily.	Power drop in S/C due to transponder on for 2 hours/ none required.	A-01252

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
66 A-01253	11/27/91 4782)	TLM&DH	2	Similar to Index 65, above, except it was after unauthorized turn on by South Pole Station	Severe power drain because transponder on for 1 orbit/none required.	A-01253
67 A-01254	12/16/91 (4801)	INST+ERB	2	There was indication of an ERB Chopper Motor "ON CONDITION." Has happened before.	None/none – corrected itself.	A-01254
<u>NOAA-9</u>						
S/C IN STANDBY STATUS – NO ANOMALIES REPORTED IN 1991						
<u>NOAA-10</u>						
22	2/1/91 (1598)	INST+SEM	1	MEPED shows high counts on each of the 3 zero-degree electron telescope channels - detector failure from radiation.	Negligible/ none possible.	305
23	5/7/91 (1693)	INST+SEM	1	SEM TED bias level increased. DPU 12 volt internal supply voltage dropped to 5 volt.	Diminished data quality/ none possible.	307
<u>NOAA-11</u>						
21	3/29/91 (916)	TLM&DH	1	Digital tape recorder playbacks via S-band Transmitter-2 are occasionally received as noise data at Fairbanks Station.	Negligible/ Will investigate.	306
22	5/9/91 (957)	INST+AVHRR	1	Instrument experienced 3 re-syncs plus an increase in motor current and chan. 3 noise. (Bearing lube problem).	Negligible/ Increased temp. to help bearing lube.	308
23	5/9/91 (957)	TC&C	1	Command Receiver RX A/B received undesired CIU commands which caused the RXO Primary CMD-1 to be enabled.	Non-destructive command/none possible.	314

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
24	10/18/91 (1119)	TLM&DH	1	Digital Tape Recorder-IB repeatedly did not respond properly to tape movement commands.	Negligible/ Problem under investigation	315
<u>NOAA-12</u>						
1	5/14/91 (0)	ACS	1	High pressure N ₂ telemetry readout dropped to 0 counts and returned to normal in 2 orbits.	None/none required.	309
2	5/15/91 (1)	TLM&DH	1	Solar array hinge #7 telemetry readout is intermittent.	None/None - not used any more.	310
3	6/3/91 (20)	INST+SEM	1	Digital Chan.-A temp. readings and proton telescope bias readings are,incorrect.	Science not affected/none - will monitor.	311
4	8/14/91 (92)	POWER	1	Battery 1 charge current went down 200 milliamps due to radiation pickup.	None/none required.	312
5	9/2/91 (111)	TC&C	1	Command Receiver RX A/B received erroneous CIU Cmd which caused RXO to go from "backup" to "prime" side.	Non-destructive command/none possible.	313
6	10/20/91 (159)	INST+AVHRR	1	Instrument has been periods of high-sync jitter and motor current changes.	Annoyance/fix disabled TCE to allow 3-11 deg. temp. rise.	318
7	11/29/91 (199)	INST+SEM	1	TED high voltage power supplies switched off without being commanded.	Loss of output/ recycled off and on – being investigated.	316
<u>TDRS-1</u>						
**61	[12/5/90] (2802)	INST+ PAYLOAD	2	Multiple Access (MA) local oscillator changes state to unlocked condition and then returns to locked-happened many times in past.	Brief telemetry interruptions/ collect data and investigate.	110

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
62	9/4/91 (3075)	INST+ PAYLOAD	2	Experienced loss of SSA-1 return link signal pedestal. First attempt of use in 34 days.	Loss of link/ testing shows return processor is problem.	119
<u>TDRS-3</u>						
NO ANOMLIES REPORTED IN 1991						
<u>TDRS-4</u>						
**15	[10/15/90] (581)	POWER	2	When exiting eclipses there have been delayed responses to battery disconnect commands sent when 2 solar array temp's exceed 68 DEG F.	Minimal/none protection circuits are performing as designed. Operational procedure modified.	109
16	4/9/91 (757)	ACS	2	RGA-A (Earth Sensor Ass'y.) started showing changes on roll and pitch outputs and led to failure of ESA-A.	Short lose of attitude control/ recover attitude control using ESA-B and EIE-B.	111
17	5/20/91 (798)	TC&C	1	When switching Cmd Rcvr-A from S-Band to K-Band telemetry indicated no switch even though switch had been made.	Negligible/telemetry cleared by switching back to S-Band and then K-Band	112
18	6/4/91 (813)	ACS	1	The ESA-B pitch and roll outputs were corrupted for a duration of 2 telemetry mainframes (or on ESA compute cycle) – cause unknown.	Negligible/none – has not repeated.	113
19	6/20/91 (829)	ACS	1	After being turned on for a delta velocity maneuver gyro 1/1 took over 7 minutes to indicate sync (normal is 30-65 sec.)	None, performance of gyro was ok/ analysis indicates sync circuit problem.	114
20	7/5/91 (844)	INST+ PAYLOAD	2	K-Band telemetry carrier disappeared from its normal place in the composite down-link spectrum. master Freq. Generator (MFG-A) is guilty.	Five hour loss of K-Band telemetry/ switch to MFG-B fixed problem.	115

<u>INDEX</u>	<u>DATE/(DAYS)</u>	<u>SUBSYSTEM</u>	<u>CRITICALITY</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF.</u>
<u>TDRS-5</u>						
1	8/13/91 (11)	PROPULSION	1	Z3 Dual Thruster Module (DTM) temp. is "dithering," however it is controlling the module temperature as designed.	None/none required.	116
2	8/10/91 (8)	ACS	1	A momentum failsafe occurred when gyro 1/1 was commanded on for the first time – gyro start-up activated momentum failsafe circuit as designed.	S/C pitch error and normal mode outputs were disabled/gyro start-up	117
3	8/10/91 (8)	ACS	1	Apparent SEU-event caused the P_ESA_S parameter to momentarily exceed its caution limit. This “pitch glitch” probably caused by hit in CTE Buffer.	Negligible/none required – has happened before on other TDRS S/C.	118
4	8/23/91 (21)	INST+ PAYLOAD	1	During TDRS-5 testing, a KSA2F signal was seen in KSA1R spectrum when SA1 antenna was pointed at WSGT – no impact.	None/tests indicate problem in S/C itself.	120
<u>UARS</u>						
1	10/8/91 (23)	INST+CLAES	1	Twice the A-side electronics pulse bus DC-DC converters overvoltage protection circuit switched off the three converters.	Negligible/change operating procedures.	A-01491

* Date in parenthesis is approximate.

** Not reported in CY 1990 Annual Report.

APPENDIX A

SPACECRAFT LIFETIME DATA

NOTE: In the following table, the term “useful life” refers to the time during which the major mission objectives were met. Active life is the total lifetime during which the satellite remained in service. A blank space means the information was not available. Data is through 1991; see text for update.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
TIROS	4/1/60	0.25	.24	.24	TV system useful for 77 days
Explorer VIII (S-30)	11/3/60	0.25	.15	.15	Last transmission 12/28/60
TIROS-II	11/23/60		.63	1.03	TV data useful to 7/12/61
Explorer XI (S-15)	4/27/61		.61	.61	Last transmission 12/7/61
TIROS-III	7/12/61	.25	.40	.63	TV data useful to 12/4/61. Lost tape recorders.
Explorer XII (S-3)	8/15/61	1.0	.31	.31	Transmission ceased abruptly
TIROS-IV	2/8/62	0.25	.36	.44	TV useful to 6/9/62. Lost tape recorders.
OSO-I	3/7/62	0.5	1.40	1.40	Lost tape recorder @ 2 mos. starfish incident degraded power system.
Ariel-I (S-51)	4/26/62	1.0	0.88		Degraded by starfish incident of 7/9/62.
TIROS-V	6/19/62	0.5	0.88	0.88	TV useful to 5/4/63. Camera filaments failed.
TIROS-VI	9/18/62	0.5	1.06	1.06	TV useful to 10/11/63. Filaments and focus out.
Explorer XIV (S-3a)	10/2/62		0.85	1.20	Last transmission 2/17/64
Explorer XV (S-3b)	10/27/62	0.17	0.26	0.55	Despin system failed. Last transmission 5/19/63.
Relay I	12/13/62	2.0	2.53	2.53	
Syncom I	2/14/63	2.0	0	0	Lost power, mission failure.
Explorer XVII (S-6)	4/3/63	0.25	.27	.27	Batteries degraded. No solar array.
TIROS-VII	6/19/63	0.5	4.33	4.96	Deactivated. Camera focus out 12/65.
Syncom II	7/26/63	2.0	N/A	N/A	
IMP-A	11/26/63	1.0	0.82		
TIROS-VIII	12/21/63	0.5	3.53	3.53	Deactivated.
Relay-II	1/21/64	1.0	1.68	3.50	
Ariel-II (S-52)	3/27/64	1.0	0.53		Had spin rate and attitude control problems.
Syncom III	8/19/64	3.0	N/A	N/A	
Explorer XX (S-48)	8/25/64		1.60	1.60	Based on last transmission 3/30/66.
Nimbus-I	8/28/64	0.5	0.07	0.07	Solar array drive failed.
OGO-1(A)	9/4/64	1.0	5.23	5.23	Mission failure. 3-axis stabilization not achieved.
IMP-B	10/3/64	1.0	0.50	1.25	Reentered. Placed in wrong orbit.
Explorer XXVI (S-3c)	12/21/64	1.0	2.10	2.10	Last transmission 1/21/67.
TIROS-IX	1/22/65	0.5	2.73	3.4	Deactivated. Camera contrast out 10/66.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
OSO-II	2/3/65	0.5	0.75	0.75	Used up control gas.
IMP-1(C)	5/29/65	1.0	1.92	1.92	Reentered.
TIROS-X	7/2/65	1.0	1.16	2.00	Deactivated.
OGO-2(C)	10/14/65	1.0	3.48		Mission failure: Horizon scanners did not maintain earth lock.
ESSA-I	2/3/66	1.0	2.36	2.36	Deactivated.
ESSA-II	2/28/66	1.0	4.64	4.64	Deactivated.
OAO-I	4/8/66	1.0	0	0	Mission failure: Lost power
Nimbus-II	5/16/66	0.5	2.67	2.67	ACS scanner failed.
AE-B	5/25/66	0.5	0.82		Higher than planned orbit. Two sensors did not work.
OGO-3(B)	6/6/66	1.0	2.04	3.5	Boom oscillation problem.
AIMP-2(D)	7/1/66	0.5	4.92		Failed to achieve lunar orbit.
ESSA-III	10/2/66	1.0	2.02	2.02	Deactivated. Cameras failed
ATS-I	12/6/66	3.0		ACTIVE	Gas expended. Limited service
ESSA-IV	1/26/67	1.0	0.41	1.27	Deactivated. One camera failed, one degraded.
OSO-III	3/8/67	0.5	3.0	3.0	Tape recorder failure at 18 mos. ACS controlled manually.
ESSA-V	4/20/67	1.0	2.83	2.83	Deactivated. IR failed, cameras gradually degraded.
IMP-3(F)	5/24/67	1.0	1.95	1.95	Reentered.
AIMP-4(E)	7/19/67		3.50	3.50	Lunar orbit. Subsequent period of intermittent operation.
OGO-4(D)	7/28/67	1.0	2.24	2.75	Thermal bending of antenna caused stabilization control problem.
OSO-IV	10/18/67	0.5	0.90		Tape recorder failure at 6 mos.
ATS-III	11/5/67	3.0		ACTIVE	Instruments no longer in use
ESSA-VI	11/10/67	1.0	2.09	2.09	Deactivated Cameras degraded
OGO-5(E)	3/4/68	1.0	3.60	3.60	Deactivated. Data glut
RAE-A	7/4/68	1.0	4.50	4.50	Deactivated. Data quality had become marginal.
ESSA-VII	8/16/68	1.0	0.92	1.56	Deactivated. Early camera and tape recorder failures
OAO-II	12/7/68	1.0	4.20	4.20	Prime instrument (WEP) failed.
ESSA-VIII	12/15/68	1.0	4.95	6.75	Deactivated. Camera problems
OSO-V	1/22/69	0.5	3.9	3.9	

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
ESSA-IX	2/26/69		4.1	4.1	Deactivated. Standby after 4/71.
Nimbus-3	4/19/69	0.5	2.67		ACS Scanner failed 1/72.
OGO-6 (F)	6/5/69	1.0	2.06	2.25	Deactivated. Data glut
IMP-5(G)	6/21/69		3.51	3.51	Reentered.
OSO-VI	8/9/69	0.5	3.30	3.30	
ATS V	8/12/69	3.0	14.84	14.84	Mission officially unsuccessful: Stabilization not achieved. Deorbited 3/20/84
TIROS-M	1/23/70	1.0	1.40	1.40	Momentum wheel assembly failed.
Nimbus-4	4/8/70	1.0	10.00	10.00	Deactivated.
NOAA-1 (ITOS-A)	12/11/70	1.0	.56	0.75	Deactivated. Momentum wheel assembly problems.
SAS-A	12/12/70	0.5	4.00	4.00	Transmitter failure terminated mission.
IMP-6(I)	3/13/71	1.0	3.56	3.56	Reentered.
OSO-VII	9/29/71	0.5	3.17	3.17	Reentered due to bad orbit
SSS-A	11/15/71	1.0	2.87	2.87	Deactivated. Battery unusable, as expected after 1 year.
Landsat-1 (ERTS-A)	7/23/72	1.0	5.58	5.58	Deactivated: Funding withdrawn
OAQ-C	8/21/72	1.0	8.50	8.50	Deactivated: Funding withdrawn
IMP-7(H)	9/22/72	2.0	6.10	6.10	Power system failed.
NOAA-2 (ITOS-D)	10/15/72	1.0	2.25	2.40	Standby after 3/74. Some experiments failed.
SAS-B	11/16/72	0.5	.54	.54	Experiment low voltage power supply failed.
Nimbus-5	12/12/72	1.0	10.30	10.30	Deactivated 3/31/83. Second HDRSS failed 7/27/82.
RAE-B	6/10/73	1.0	3.75	3.75	Deactivated. Mission objectives achieved.
IMP-8(J)	10/25/73	2.0	ACTIVE	ACTIVE	All instruments operating.
NOAA-3 (ITOS-F)	11/6/73	1.0	2.84	2.84	Deactivated. Radiometer, VTPR, VHRR out
AE-C	12/16/73	1.0	5.00	5.00	Reentered.
SMS-1	5/17/74	2.0	1.60	6.70	Standby after 1/76. Deactivated 1/31/81.
ATS-6(F)	5/30/74	5.0	5.17	5.17	Deactivated.
NOAA-4 (ITOS-G)	11/15/74	1.0	4.00	4.00	Deactivated. Radiometer, VHRR's out.
Landsat-2	1/22/75	1.0	8.51	8.51	Yaw flywheel stopped 11/79, recovered 5/80. Permanently turned off July 27, 1983.
SMS-2(B)	2/6/75	2.0	6.50	7.50	Second encoder failed on 8/5/81.
SAS-C	5/7/75	1.0	4.92	4.92	Reentered.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
Nimbus-6(F)	6/12/75	1.0	7.18	8.28	Yaw flywheel failed 8/14/82.
OSO-8(I)	6/21/75	1.0	3.40	3.40	Funding withdrawn
AE-D	10/6/75	1.0	0.42	0.42	Shorted diode in power supply electronics.
GOES-1(A)	10/16/75	3.0	9.3	9.4	VISSR failed 2/85
AE-E	11/20/75	1.0	5.56	5.56	Reentered 6/10/81
NOAA-5 (ITOS-H)	7/29/76	1.0	2.96	2.96	Failed 7/79
GOES-2 (B)	6/16/77	3.0	1.55	1.55	VISSR failed 1/79
ISEE-1(A)	10/22/77	2.0	9.93	9.93	S/C re-entered 9/26/87
IUE	1/26/78	3.0	ACTIVE	ACTIVE	Fully operational. Some problems w/ computer "HALTS"
Landsat-3(C)	3/5/78	3.0	5.07	5.51	Problems with MSS instrument
AEM-A (HCMM)	4/26/78	1.0	2.40	2.40	Deactivated. Battery degraded 9/14/80.
GOES-3(C)	6/16/78	3.0	2.21	7.89	VISSR degraded 9/80. Failed 5/6/81. S/C to standby 4/28/86.
ISEE-3(C) [ICE]	8/12/78	2.0	ACTIVE	ACTIVE	Some instrument losses.
TIROS-N	10/13/78	2.0	2.38	2.38	ACS failed 2/27/81.
Nimbus-7(G)	10/24/78	1.0	ACTIVE	ACTIVE	Solar array power and some instruments degraded.
AEM-B (SAGE)	2/18/79	1.0	2.75	2.75	Battery degraded. Failed 11/18/81.
NOAA-6(A)	6/27/79	2.0	7.39	7.75	S/C turned off 3/31/87
Magsat	10/30/79	0.4	.61	.61	Reentered as planned 6/11/80
SMM*	2/14/80	2.0	[0.83] +[5.62]	9.78	Lost fine pointing control 12/12/80, then repaired. Mission terminated 11/24/89: re-entered 12/2/89.
GOES-4(D)	9/9/80	7.0	2.21	6.66	VAS failed 11/25/82.
GOES-5(E)	5/22/81	7.0	3.19	9.2	VAS failed 7/30/84. Loss of Station-keeping 12/89. De-activated 7/18/90. Out of station-keeping fuel.
NOAA-7(C)	6/23/81	2.0	3.62	4.92	Failed HIRS, degraded SSU, disabled power system.
DE-1(A)	8/3/81	1.0	9.57	9.57	Mission terminated (can't command S/C) 2/28/91.
DE-2(B)	8/3/81	1.0	1.54	1.54	Reentered as expected 2/19/83.
OSS-1	3/22/82	--	--	--	Shuttle attached payload mission.
Landsat-4(D)	7/16/82	3.0	ACTIVE	ACTIVE	Partial solar array loss, X-Band failed.
NOAA-8(E)	3/28/83	2.0	1.25	1.25	Failed 7/1/84. Recovered May 1985. Failed again 1/86.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
TDRS-1(A)	4/4/83	**	ACTIVE	ACTIVE	Some loss of capability. Orbital spare in early '89. VAS failed 1/21/89..
GOES-6(F)	4/28/83	7.0	5.73	ACTIVE	
Landsat-5(D')	3/1/84	3.0	ACTIVE	ACTIVE	
AMPTE/CCE	8/16/84	1.0	4.92	4.92	
ERBS	10/5/84	2.0	ACTIVE	ACTIVE	Some solar array degradation. Mission terminated 7/14/89.
NOAA-9(F)	12/12/84	2.0	3.92	ACTIVE	IRU-1/X-gyro failed (8/86), IRU-2/Y-gyro failed (7/88), IRU-1/Y gyro failed (11/89), ERBE-S failed (2/90), IRU-2/X gyro failed (7/90).
SPARTAN-1	6/20/85	--	--	--	MSU & ERBE-S failure. Placed in standby 11/8/88.
SPOC/HITCHHIKER	1/12/86	--	--	--	STS attached payload mission
NOAA-10(G)	9/17/86	2.0	ACTIVE	ACTIVE	STS attached payload mission
GOES-7(H)	2/26/87	7.0	ACTIVE	ACTIVE	Array shunts degraded. ERBE-S & SARP failed.
NOAA-11(H)	9/24/88	2.0	ACTIVE	ACTIVE	Y-gyro & DTR 5 A & B failed in late 1989. DTR 1B failed 2/92
TDRS-3(C)	9/29/88	**	ACTIVE	ACTIVE	
TDRS-4(D)	3/13/89	**	ACTIVE	ACTIVE	
COBE	11/18/89	0.83	ACTIVE	ACTIVE	
PEGSAT	4/5/90	0.25	0.75	0.75	Standby status 8/91.
HST	4/24/90	15***	ACTIVE	ACTIVE	Gyro-B failed shortly after launch. ESA-A failed 4/91. BX Gyro failed 9/91.
SSBUV	10/6/90	--	--	--	PEGASUS. Limited life mission.
BBXRT	12/2/90	--	--	--	Spherical aberation in primary mirror. Gyros 4 & 5 failed.
GRO	4/7/91	2.25	ACTIVE	ACTIVE	STS attached payload mission
NOAA-12(D)	5/14/91	2.0	ACTIVE	ACTIVE	STS attached payload mission
TDRS-5(E)	8/2/91	*	ACTIVE	ACTIVE	Propulsion system damaged/degraded.
UARS	9/15/91	3.0	ACTIVE	ACTIVE	Class B S/C
					Class A S/C
					Class B S/C & Class C Instruments

* Repaired by crew of shuttle flight 41-C on April 12, 1984.

** Complex warranty provisions call essentially for 10-year service from TDRSS system.

*** Based on periodic servicing in orbit. MSFC launched S/C; GSFC manages operational phase.